



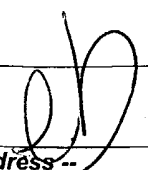
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/088,975	08/13/2002	Thomas L Ritzdorf	SEMT118781	6706
26389	7590	09/30/2004	EXAMINER	
CHRISTENSEN, O'CONNOR, JOHNSON, KINDNESS, PLLC			LEADER, WILLIAM T	
1420 FIFTH AVENUE			ART UNIT	
SUITE 2800			PAPER NUMBER	
SEATTLE, WA 98101-2347			1742	

DATE MAILED: 09/30/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b>	<b>Applicant(s)</b>	
	10/088,975	RITZDORF ET AL.	
	<b>Examiner</b>	<b>Art Unit</b>	
	William T. Leader	1742	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-31 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-31 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>3/25/2002</u> . | 6) <input type="checkbox"/> Other: ____.  |

## DETAILED ACTION

### *Claim Rejections - 35 USC § 102*

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-5, 11, 13, 14, 22-25 and 27-31 are rejected under 35 U.S.C. 102(b) as being anticipated by Anthony (4,396,467).

The Anthony patent is directed to the deposition of metal on a semiconductor workpiece with recesses. The deposition is begun by applying a dc current in the forward direction so that plating occurs in the recesses or holes (column 7, lines 34-37). To ensure balanced deposition, the dc current is changed to periodically reversed current (column 9, lines 60-64). In the embodiment shown in figure 7, a train of rectangular pulses which vary from a current level of  $I_p$  in the forward direction for a time period of  $T_p$ , to a current level of  $I_R$  in the reverse direction for a time period of  $T_R$  is applied to the workpiece (column 9 line 64 to column 10, line 2). The electric current used by Anthony meets the limitations of claims 1, 3, 22 and 25. At column 10, lines 33-36, Anthony teaches that the height of the deposit at which periodic reverse-current must begin is where the implants are within a few mils of the emergence surface. This disclosed range is considered to include heights which are almost even with but just below the top surface of the workpiece, and to fall

within the range of heights included within the scope of the expression "nominally fill" in claims 2 and 24. In one experiment,  $T_p$  was 5 seconds while  $T_R$  was 0.2 seconds). These times meet the limitations of claims 4 and 5. In an experiment,  $I_R$  was 1000 ma which is 1 amp as recited in claim 11 (column 10, lines 27-33). The metal is preferably copper and may be deposited from a bath which includes copper sulfate, sulphuric acid, and thiourea and molasses as additives (column 8, lines 15-21). This bath meets the limitations of instant claims 13 and 14. There is no indication that the product of the present process as recited in claims 23 and 27 differs from that of Anthony. The apparatus of Anthony is schematically shown in figure 4. The apparatus includes tank 24 for receiving the workpiece, electroplating bath and anode 25. The apparatus further includes DC power supply 40 and waveform generators 41 for controlling the power supply. The apparatus is capable of being operated to supply the types of current recited in claims 28-31.

3. Claims 1, 8, 13, 23 and 27 are rejected under 35 U.S.C. 102(b) as being anticipated by Carey et al (5,219,787).

The Carey et al patent is directed to a process for forming high density copper interconnects on a semiconductor workpiece by depositing copper into channels and vias (column 1, lines 14-24). As shown in figures 10-12, copper is electrolytically deposited in channel 42 and via 44 and over the surface. Excess copper is removed by chemical-mechanical polishing. Carey et al recognize that during

electrodeposition, high current densities at the top edges of the channels may cause ridge build-up of the copper which blocks the conductive material from filling the channels, and teach that reverse pulse plating can be used during electrodeposition to continually shave back ridge build-ups. Carey et al further teach that the plating bath can contain a leveling agent which also acts to prevent ridge build-up (column 5, lines 46-53). Instant claim 1 recites a step of supplying net forward power for a first time period and a step of reversing the power for at least a portion of a second time period. These steps read on the forward and reverse pulses of periodic reverse pulse plating processes such as that of Carey et al. Additionally, if the first forward pulse of Carey et al is taken as the first time period and the first reverse pulse of Carey et al is taken as the second time period, the following forward and reverse pulses meet the limitation of claim 8. There is no indication that the product of the present process as recited in claims 23 and 27 differs from that of Carey et al.

### ***Claim Rejections - 35 USC § 103***

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 6, 7 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Anthony.

The Anthony patent is taken as above. Anthony teaches that the height in the recesses or holes at which periodic reverse current must begin is where the deposits are close to the emergence surface (column 10, lines 34-36). Anthony also teaches that  $T_R$ , the reverse pulse duration, can vary with the height  $H$  of the deposit. The growth can be controlled during the entire growth process by changing the pulse duration and pulse current with time using a programmable controller. The prior art of record is indicative of the level of skill of one of ordinary skill in the art. Based on the teaching of Anthony, choice of duration of the second time periods to be greater than 10 or 60 seconds as recited in claims 6 and 7 would have been

obvious to one of ordinary skill because these periods would have been expected to produce the results suggested by Anthony. Anthony doesn't specify the voltage of the reverse electroplating power, but does state that the reverse current  $I_R$  was 1000 ma or 1 amp as recited in instant claim 11. To supply a current of this magnitude, use of a voltage of greater than 0.05 volts as recited in claim 12 would have been expected.

7. Claims 15-21 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Anthony in view of Creutz (3,770,598) and Sonnenberg et al (5,223,118).

Claims 15-21 recite constituents of the plating bath. Both Creutz and Sonnenberg et al patents disclose copper electroplating baths. The Creutz patent relates to the use of certain organic compounds in the copper plating bath to give bright, highly ductile, low stress, good leveling copper deposits over a wide range of bath concentrations and operating current densities (column 1, lines 9-13). The examples show that the baths contain a source of chlorine ions as recited in instant claim 15. The additive may be an organic polysulfide compound as recited in claim 17 (column 4, lines 29-47). The additive may be a nitrogen and sulphur-containing compound as recited in instant claim 17 (column 2, lines 6-67). The baths may also contain polyethylene glycol as recited in instant claim 21.

Sonnenberg et al discloses the inclusion of addition agents in a copper plating bath. Column 5, lines 37-41 show that a typical bath includes chlorine ions.

Column 6, lines 5-14 disclose the use of brighteners of the formula  $S-R^1-S$  as recited in instant claim 17 and levelers of the formula  $N-R_1-S$  as recited in instant claim 19.

Claim 26 differs from the process of Anthony by reciting the presence of chlorine ions in the copper plating bath. As noted, both Creutz and Sonnenberg et al show the inclusion of chlorine ions.

It would have been obvious at the time the invention was made to have utilized conventional addition agents in the copper plating bath of Anthony as taught by Creutz and Sonnenberg et al because the properties of the deposited copper would have been improved.

8. Claims 1, 3-7, 11-14, 22, 23, 25 and 27-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Carey et al (5,219,787) in view of Anthony (4,396,467).

Carey et al and Anthony are interpreted and applied as above. Instant claim 1 may be read as requiring the second time period to be more comprehensive than a simple reverse pulse. For example, the second time period may include both forward and reverse pulses as recited instant claims 3, 25 and 26. Thus, claim 1 may be interpreted as including a first time period in which a forward direct current is applied and a second time period in which periodically reversed pulse current is applied. This is the sequence of current application disclosed by Anthony. As noted



above, Carey et al suggests the use of either forward dc current or periodic reverse pulse plating. Claims 1, 3, 25 and 26 lack an inventive step since it would have been obvious at the time the invention was made to have begun the deposition process of Carey et al using forward dc current and then to have changed to periodic reverse pulsed current as taught by Anthony because faster deposition at the beginning of the process would have been obtained while ridge build-up would have been prevented as it became detrimental. The limitations of the other dependent claims would have been obvious for the reasons discussed above with respect to Anthony.

9. Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Carey et al in view of Harrover, Jr. (2,853,443) or Jernstedt (2,451,341).

Claims 9 and 10 differs from by reciting that the second time period during which reverse electroplating power is supplied is greater than or equal to 1 second or 5 seconds, respectively. Carey et al suggest the use of periodic reverse pulse plating, but does not disclose specific durations of the pulses. The Harrover, Jr. patent is discloses a process for depositing copper from an additive-containing copper plating bath using reverse pulsed current. As shown in figure 2, the duration of the cathodic plating pulses may range from 1/100 to 100 seconds while the duration of the anodic deplating pulses is at least 1/12 of the duration of the

plating pulses. The process provides a smooth, sound copper deposit (column 6, lines 33-40).

The Jernstedt patent is directed to an electroplating process using reverse pulsed current. The duration of the cathodic plating pulses ranges from about 2 to 40 seconds. The duration of the anodic deplating pulses ranges from 1/2 to 10 seconds. See figure 2. The process allows superior deposits to be obtained (column 3, lines 27-32).

It would have been obvious at the time the invention was made to have utilized pulse durations falling within the ranges taught by Harrover, Jr. or Jernstedt in the reverse pulse plating process of Carey et al because smooth, sound deposits of superior quality would have been obtained.

10. Claims 15-21 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Carey et al in view of Creutz and Sonnenberg.


Carey et al, Creutz and Sonnenberg are interpreted and applied above. Claims 15-21 and 26 lack an inventive step since it would have been obvious at the time the invention was made to have utilized conventional addition agents in the copper plating bath of Carey et al as taught by Creutz and Sonnenberg et al because the properties of the deposited copper would have been improved.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to William T. Leader whose telephone number is 571-272-1245. The examiner can normally be reached on Mondays-Thursdays and alternate Fridays, 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Roy King, can be reached on 571-272-1244. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

  
William Leader  
September 24, 2004

  
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